Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
INQUIRY REGARDING CARRIER CURRENT SYSTEMS, INCLUDING BROADBAND OVER POWER LINE SYSTEMS	)	**ET Docket No. 03-104**

To: The Commission

REPLY COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

ARRL, the National Association for Amateur Radio, also known as the American Radio Relay League, Incorporated (ARRL), by counsel, hereby respectfully submits its reply to those comments filed in response to the *Notice of Inquiry* (the Notice), FCC 03-100, released April 28, 2003, 68 Fed. Reg. 28182; *corrected* 68 Fed. Reg. 32720. The Notice requests information on the current state of Broadband Power Line (BPL) technology. These comments are timely filed, in view of the *Order Granting An Extension of Time to File Reply Comments*, DA 03-2590, released August 1, 2003. For its reply comments, ARRL states as follows.

I. Introduction

1. The Commission, in this proceeding, must realize one basic fact. The High Frequency (HF) spectrum is a unique, irreplaceable, global natural resource. It provides worldwide radio communication without the need for any infrastructure. By contrast, BPL simply duplicates existing means of providing broadband services to consumers using an inferior technology that, as has been clearly demonstrated by the ARRL, would cause widespread spectrum pollution and severe degradation of the unique HF resource.

As stated in its comments, ARRL's interest in this proceeding is related to the interference potential of BPL to Amateur Radio medium-frequency (MF), HF, and very-high frequency (VHF) communications, and, conversely, the potential for Amateur Radio to interfere with BPL in those same frequency ranges. Unfortunately, the comments in this proceeding from entities advocating BPL fail, in the main, to address the interference potential or susceptibility of BPL. Instead, as is normally the case when an unlicensed device or system is advocated, the public benefit of the system or device is touted, and the interference characteristics are left unexplored. ARRL views BPL as having an extremely high and widespread interference potential, and this proceeding is of overriding concern to Amateur Radio operators nationally and worldwide. By far, the overwhelming majority of comments filed in this proceeding were those of radio amateurs. Their arguments clearly illustrate what should be obvious to the Commission: that BPL is an interference threat to each and all of the MF, HF and low band VHF amateur allocations. In these reply comments, ARRL will not debate the utility of BPL as a competitive broadband delivery mechanism, though ARRL believes it to be substantially inferior to other delivery mechanisms. It is hoped that the Commission will recognize that the utility of BPL is not relevant if it is determined, as it must be, that access BPL implementation will result in destructive interference to hundreds of thousands of active Amateur Radio operators. It simply cannot be allowed.

2. ARRL has demonstrated in its comments, based on a series of technical studies and calculations, that there is a severe interference potential from BPL in the bands between 1.7 and 80 MHz to Amateur Radio stations. Since that time, ARRL has completed some field measurements of BPL demonstration systems in various parts of

the northeast and Middle Atlantic States. A summary of those measurements and the results are included in these reply comments as Exhibit A. Those measurements confirm the conclusions drawn from the calculations in this proceeding. ***The Commission cannot allow BPL to operate in the 1.7-80 MHz range, because it will cause severe interference to licensed, over-the-air radio services.*** BPL would be using all of the frequencies suitable for practical international Amateur Radio communications simultaneously. They would be used at all the times that Radio Amateurs would use them. There is no practical frequency or time shift that will allow amateurs to coexist with BPL. The circumstances pose a complete incompatibility.

3. ARRL has completed two additional studies, attached hereto as Exhibits B and C, which further address the interference potential of BPL to Amateur stations. The first is a study of BPL and Conducted Emissions. The electromagnetic compatibility (EMC) environment in which all electronic devices function includes both radiated and conducted factors, and the Commission's Rules address both. This study concludes that BPL systems, as configured per information from the BPL industry, will change the conducted EMC environment from the present level of +48 dBuV peak in a 9 kHz bandwidth to a level of +96.5 dBuV , an increase of 48.5 dB. The BPL industry is asking that this be raised by at least 10 dB. Many BPL systems use high-pass couplers which allow the BPL signals to be transmitted around step-down transmitters, which normally offer significant attenuation to noise signals generated on the low-voltage side. All of these factors and changes mean that the level of conducted noise power possibly affecting all types of equipment connected to the lines could increase by more than a million times, which most certainly will have an adverse effect on the present EMC environment that

has developed around present Commission regulations, industry standards, and deployed equipment. Affected equipment includes consumer devices in homes, medical equipment used in homes and medical facilities connected to the power lines, and many other devices and systems. The effect of an approximate 60 dB change in the EMC environment is as yet unexplored, and scientific testing is required. Generalized statements by BPL advocates suggesting that there is no interference potential because no reports have been received from trial areas is not a sufficient response, nor a substitute for scientific testing by manufacturers whose products stand to be affected by such a large change in the EMC environment. The conducted interference levels from BPL were the subject of comments filed in this proceeding by GE Medical, which noted substantial concerns about significantly increased conducted levels causing interference to sensitive medical equipment.

4. The last study, Exhibit C, is an analysis of man-made noise from BPL systems operating at the current FCC Part 15 radiated emission limits on worldwide HF communications. This study analyzes the effect on skywave propagation of BPL noise in terms of predicted communications circuits on two typical Amateur Radio HF allocations (14 MHz and 5 MHz). The conclusions from this study are that the present levels of noise from unlicensed devices and other sources is at the edge of degradation of the ability to communicate using a typical Amateur station on the subject bands. Even a modest increase over the present median noise levels described in ITU-R P.372-8 [1] has a significant adverse effect on the reliability and range of HF communications. Even a very conservatively premised 10 dB degradation of communications would result in

transformation of the 14 MHz Amateur band from a worldwide communications band as it is now to one of limited regional communications capability, assuming power levels typically deployed at Amateur stations. The point is that any change in the rules for unlicensed devices or in the nature of systems deployed under the present rules can tip the scales of this delicate balance. If the environment is changed from the present one, in which most HF Part 15 devices are single-source emitters limited in geographical scope, duration of emissions and frequency of emission to an environment where devices emit on wide swaths of spectrum throughout wide geographic areas, the effect will be much greater than the modest 10 dB increase in the median value of man-made noise that the calculations in this study show to be significant.

II. The BPL Advocates Fail to Address Interference Potential to Licensed Services

5. The greatest number of comments filed to date were, as previously noted, from Amateur Radio operators and groups concerned about interference from BPL to the Amateur Service. The remainder were filed by individual BPL companies, BPL industry groups, and utility companies. For the most part, the industry comments lacked technical substance. Any further action by the Commission in this proceeding must be taken in light of the answers to the questions asked in the Notice, rather than the generalized marketing proposals offered by the industry. As a whole, the BPL industry seeks higher radiated emissions limits, in order to increase range and throughput. Their *only* justification for this is that they have no reports of interference from their trial areas. This, however, is not a meaningful argument. First of all, not all companies that state that

[1] The "residential environment is described in ITU-R Recommendation P.372-8 (2003), "Radio Noise". This is -163.5 dBW/Hz at 14 MHz (extrapolated from -145 dBW/Hz on 3 MHz using Formula 11 described

no interference has occurred from the field trials have offered any information about those trials – the number of homes involved; the nature of the distribution wiring; the power levels involved; the frequencies used by the system and the measured results of the verification they have had to do under the rules. They apparently expect licensed radio stations that operate on HF bands to accept on faith that this complex subject has been fully and adequately addressed by the industry. In fact, it has not. The Commission cannot make any decisions based on the BPL advocates' overly simplified summary of their field trial results. Nor has there been any investigation whatsoever of the interference susceptibility of BPL systems, which is the other half of the equation in residential environments.

6. The comments of the National Telecommunications and Information Administration (NTIA) in this proceeding illustrate the problem. NTIA notes appropriately that, "(i)n tailoring its rules…the Commission must be certain to provide all communications stakeholders with adequate protections against BPL emissions that may cause unacceptable radio frequency interference." NTIA has not, however, yet conducted measurements of experimental BPL systems, or modeling and analyses that address the interference potential of BPL technology and the radiated emission limits that are necessary in order to preclude unacceptable interference to federal government systems. NTIA anticipates completing its studies by the end of 2003." ARRL would submit that any generalized conclusions drawn by the BPL industry in comments filed to date regarding the absence of interference potential of BPL based on test sites are both premature and meaningless.

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in that document).

7. There are two industry groups representing the BPL industry generally: the Power Line Communications Association (PLCA), a coalition of manufacturers and electric utility companies, and the United Power Line Council (UPLC), a similar coalition that is a subgroup of the United Telecom Council (UTC). PLCA's comments request "limited revisions to the rules." They don't, however, indicate what revisions to the rules are sought. PLCA notes instead that PLCA member companies will tell the Commission what is needed. However, PLCA's comments make the following statement:

> For its part, the PLCA urges the Commission to give primary consideration to actual field tests and surveys of entities offering and testing BPL services and products. The Commission must discount speculative and self-serving comments by parties who seek only to hinder the deployment of BPL technology.

Unfortunately, however, the results of the "field tests" conducted by "entities offering BPL" have not been made part of the public record, so the Amateur Radio community can only presume they don't exist. If any industry reports of these field tests do exist, and if they are to be used by the Commission to make any regulatory decisions, they should make those reports part of the record in this proceeding. Many of those who obtained experimental licenses have filed the necessary periodic reports under the cloak of "confidentiality." Under the circumstances, the Commission cannot use any of those studies for any purpose whatsoever. One is left to wonder in any case what the justification might be for giving "primary" consideration to test results provided by those "offering and using BPL services and products." Logic compels a different conclusion: "primary" consideration should be given to arguments made by those *without* substantial pecuniary interest in the implementation of the flawed technology at issue.

8. Regardless of the *argumentum ad baculum* logic of PLCA's position, the generalized reports and scanty information in this filing claim nothing more than that the systems meet FCC Part 15 requirements and that they are not causing any interference. These claims are neither quantified nor qualified, and are simply incorrect on both counts when applied to systems that will occupy large geographical areas physically shared with radio communications services. The laws of physics of radiated signals, field strength and antenna capture area have proven to be valid predictors of the interference potential from all systems.

9. UPLC and many others ask that BPL systems and environs be classified as Class A [Class A digital devices are intended for use and marketed for use in a commercial, business or industrial environment, exclusive of a device that is intended for use by the general public or intended for use in the home. See, 47 C.F.R. §15.3(h)]. This is on its face absurd. The Class B environment and rules are intended to protect residential environments from nearby *external* sources. Clearly, this should apply to any systems connected to residential building and distribution wiring. The BPL industry argues that it is marketing products and services only to utility companies, so they should be considered Class A. This is akin to arguing that a personal computer manufacturer sells computers only to computer stores, and therefore personal computers should be classified as Class A devices. The fallacy in the argument is that the devices and systems are intended for and will be marketed to and used by consumers in residential neighborhoods, as will BPL.

10. UPLC repeats PLCA's mantra that the field-trial systems meet Part 15 specifications and have not generated any interference reports. This is apparently its sole

basis for justifying a somewhat veiled request for higher radiated emission limits. This is an inappropriate justification. The trial areas range from very small, with fewer than a dozen homes in the trial, to moderate in size, with a few hundred homes. These do not represent a wide range of installations. To the contrary, the sites ARRL has visited have all been in areas of single-family homes, some with exclusively underground wiring. There has not been provided by BPL advocates a legitimate basis on which to assess the interference potential of BPL to date. (ARRL has, however, provided such, both in its Comments in this proceeding and in the attachments to these Reply Comments). None of the BPL trials has intentionally included amateur radio operators. None has included training to help customers understand the technical implications of the study. **ARRL has in fact done what the BPL industry should have done – brought an Amateur station to the trial area. When it did so, the interference was manifest and widespread, and would be so even to an untrained observer. The ARRL field visits objectively confirmed what its own calculations predicted: that Part 15-level radiated BPL emissions will result in strong interfering signals to nearby Amateur Radio antennas.**

11. UPLC also states that coupling noise signals that are conducted onto building wiring around the transformers will *not* increase the likelihood of interference. The antenna modeling that ARRL has done establishes that overhead wiring is a good radiator, and that UPLC's claim is patently incorrect. The issue is moot anyway, because if a radiated emission is at the FCC Part 15 limit, it matters not at all whether it is radiated by house wiring or overhead medium voltage lines. At the radiated emissions limit, it will

result in strong signals to nearby antennas, which will cause substantial interference and therefore not be in compliance with the Part 15 regulations.

12. UPLC and others ask that the Commission retain the radiated emissions limits instead of using conducted tests to establish compliance, admitting that the measurements are difficult. The reason for this is apparent: if a conducted limit is set at the power level some BPL manufacturers have told the Commission they are using, the level would be 48.5 dB higher than the present Class B conducted emissions limits. They also want to have the "flexibility" that the "three typical installations" measurement procedure specified under Section 15.31(d) of the Commission's Rules offers. ARRL's comments, however, showed that unless a very large number of points are measured, many of which must be at a higher height than the radiating structure, it is not possible to use a limited number of measurement points to predict field strength. BPL systems vary so much that every installation would have to be measured at sufficient points to ensure actual compliance. In fact, BPL is uniquely unsuited for Part 15 regulation in any case, due to its radiation all along a transmission line.

13. UPLC and other BPL advocates argue for retention of the presently applicable verification procedure for BPL systems. ARRL strongly disagrees. Measuring field strength *in situ* is not an easy task, and ARRL has experienced repeated instances of incorrect and inappropriate measurement techniques by others, such as measuring the fields at a height of 1 meter above ground as the only measurement height. Instead of verification, individual BPL systems and installations would have to be subject to certification, ensuring independent technical review of the test methods and results. Testing of these systems would, in addition, have to be done when they are heavily

loaded, treating the entirety of the emission of the system as a single device. If all of the appropriate measurement factors are applied, no access BPL system would be found in compliance with FCC Part 15 regulations.

14. With certification, sufficient test results would be publicly available which would, at least, allow radio amateurs to determine whether a particular piece of equipment is the cause of a specific case of harmful interference. With verification, manufacturers are under no obligation to provide test data to anyone. In ARRL's several years of experience, there has been only one instance in which a manufacturer of Part 15 equipment has been willing to supply such data upon ARRL's request. With respect to BPL systems, no company has provided any frequency information about its system, nor any specific measurements of field strength and the test conditions used to measure that field strength. ARRL strongly urges that BPL not be permitted at all in the bands between 1.7 and 80 MHz. The comments of UPLC and other BPL advocates indicate that they cannot be relied upon to properly evaluate the interference potential of BPL systems in any case.

15. The comments of International Broadband Electric Communications, Inc. are typical of the genre. Those comments assert, for example, that "experience with BPL systems to date indicates … that the emissions limits can be increased without causing harmful interference to others." This is an unsupported conclusion, based apparently on little more than wishful thinking and the flawed premise that because no interference has yet been reported from the small trial areas to date, interference cannot exist. In fact, ARRL's tests have measured interference from these test sites, and the attached Exhibit A demonstrates that International Broadband's vacuous conclusion is incorrect. If there are

any studies that have been done to support the non-interference conclusion, they should be made public.

Those comments also claim that they are unaware of interference resulting from operation of devices under the carrier-current systems rules. As but one example of major interference involving a carrier-current device that has been widely deployed, the Phonex Model PX-421 wireless modem jack caused severe interference to Amateur Radio. The details of that matter are available at <http://www.arrl.org/tis/info/rfiteljx.html>.

16. International Broadband's comments also claim that "(e)xperience shows that the BPL signal can travel farther and/or achieve greater data throughput *at higher emission levels* without causing harmful interference to other users." ARRL suggests that this claim is patently false, but it is impossible to quantitatively evaluate, because no technical justification for the claim is offered. What experience exists with BPL signals at "higher emission levels?" What are the higher levels at which interference studies were conducted? ARRL would invite this organization to reveal publicly what its "experience shows," so that others may analyze it.

17. International Broadband also raises the issue of Class A versus Class B regulatory status for BPL. Their comments state as follows:

> Class A limits should apply to BPL access systems regardless of whether they are located in residential, commercial or industrial neighborhoods. Medium voltage electric utility facilities operating at thousands of volts cannot be characterized as a 'residential environment.' The term 'residential environment' refers to the inside of a dwelling. These facilities do not pass through residential dwellings. Their proximity to residential dwellings are limited by the NESC. Moreover, while the Commission in most cases can classify the inside of a structure as being residential,

> commercial or industrial in use, the commission lacks any practical ability to classify neighborhoods, many of which contain a variety of uses and structures.
>
> Clearly, in the underground or conduit configuration, the utility facility is contained within its own 'environment' the utility facility is contained in its own 'environment' that is physically separated from other nearby 'environments." The BPL access systems in underground or conduit configurations clearly fall under the Class A limits.

The claim that the term 'residential environment' refers to the inside of a dwelling" cannot be correct, because the Class A and B definitions in Section 15.3(h) and (i) of the Commission's Rules speak in terms of whether or not Class A or B devices are marketed to the general public *or* are for use in a residential environment on the one hand, or whether they are exclusive of use by the general public, or for use in the home. It cannot be that immediately outside of homes in an exclusively residential area, a person could generate audio noise at a level that is appropriate only in industrial, commercial or business environments. Regardless, if BPL signals will exceed the Class B limits on nearby residential properties, outside of dwellings, Class B restrictions on those emissions must be applied, since almost all Amateur Radio antennas are located outdoors and many are closer than 30 meters separation from power lines.

18. A final note with respect to these unsubstantiated comments of International Broadband is with regard to the following quote:

> "While it may appear counterintuitive, higher emissions limits for BPL may tend to minimize the impact on other users. Higher limits would enable electric utilities and their service partners to construct BPL systems at lower expense and higher throughput. This will enable them to sign up more customers faster. The sooner they do, the sooner they will extend fiber to serve those customers, converting increased portions of their systems from RF to photonic technology."

This is an admission against interest. It is essentially a concession that BPL will create interference to licensed radio services, and that broadband delivery should instead be conducted by fiber optic cable. ARRL would agree with that suggestion. However, the idea that permitting high power BPL infrastructure will lead to conversion to fiber is a foolish suggestion. Even if it were true, it certainly cannot and does not constitute a justification for allowing BPL, which will create widespread harmful interference to hundreds of thousands of Amateur Radio licensees, as well as public safety, broadcast and other licensees in the victim bands. Obviously, if fiber broadband delivery is feasible, it should be implemented as an alternative to BPL.

19. The comments of HomePlug Powerline Alliance, an industry coalition, discount the interference effect of conducted emissions, and attempt to focus the Commission's attention on radiated emissions only. They state, in relevant part:

> Interference from BPL is largely a radiated phenomenon and not a conducted one. While BPL systems use the electrical wiring as a transmission medium, unintentional radiation is created by these systems. The Commission should continue to address this radiation from the emissions perspective as it does today, because radiated emissions are most likely to impact licensed services, not conducted emissions.

In fact, the Commission does address emissions from a conducted perspective, through the conducted emissions limits of Part 15 (47 C.F.R. §15.207). The vast majority of devices regulated under Part 15 address conducted emissions below 30 MHz, so Homeplug's statement is not substantiated by the Part 15 rules. The Commission has acknowledged that conducted emissions do affect other equipment connected to the ac mains and by imposing conducted emissions limits on most devices, they help ensure that equipment designed to operate from the ac mains will be able to do so with affordable ac-filtering designs. The power levels being asked for by some BPL advocates in this

proceeding will increase these conducted signals onto the ac mains by more than a million times, as discussed above and in the attached Exhibit B.

III. BPL Manufacturers Arguments Concerning Interference are Flawed

20. The comments of Ambient Corporation, a BPL manufacturer, report that they use a power level of –50 dBm/Hz, and that their system needs this power level. ARRL's comments showed, however, that overhead power lines would have an antenna gain of up to +10 dBi in some cases. The power level Ambient has stipulated would meet the Section 15.209 radiated emission limits only if single phases fed with couplers as described by Ambient exhibited an antenna gain of –35.2 dBi. There is a significant difference between –35.2 dBi and the +10 dBi predicted by ARRL's antenna modeling. ARRL's comments conclusively demonstrate that power distribution lines not nearly as inefficient as radiating elements as Ambient suggests.

21. The comments of Current Technologies suggest that BPL be evaluated in light of "real world scenarios" including present ambient noise. ARRL's calculations and measurements take into account the effects on HF propagation and communications of ambient noise, which in some areas is substantially adversely affected by such, including power line noise. However, BPL signals are in an entirely different category, and will result in signal levels of up to 30 dB over S-9 levels on a typical Amateur receiver, which is well beyond what would preclude Amateur HF communications entirely. Current Technologies also asserts, without support, that BPL signals "do not propagate well."

ARRL's comments illustrate that the claim is patently false. Overhead power lines are excellent radiators of HF signals, and BPL is no exception.

22. Ambient's comments indicated several techniques that could be used to have BPL systems use no more than the minimum necessary power. ARRL notes, however, that the present Ambient system does not use those techniques. The levels of man-made noise in residential environments generally come from signals that are conducted on to the power lines, and then radiated. Therefore, automatic power control techniques are not interference-determinative. Ambient and others also inform the Commission that their systems must operate well above the present levels of noise on the power-line conductors. As shown in ARRL's paper on propagation, attached hereto as Exhibit C, residential environments are being degraded by the *present* levels of man-made noise. That paper shows that a modest degradation of 10 dB to the existing levels of man-made noise will have a significant detriment on the ability of HF communications channels to establish world-wide communication. With the design of a system that will automatically increase its broadband power to 30 dB higher than the present levels of man-made noise, as described by Ambient, it is certain that HF communications will be severely impaired near *any* such system. ARRL has shown this by calculation and by practical evaluations of interference levels at several of the BPL test sites.

23. Ambient has also indicated that the present levels of man-made noise from defects on the power line must be corrected for BPL to work. This is, however, an impossible task. The track record of the electric utility industry in correcting routine power-line noise problems is generally poor. ARRL can document a large number of cases in which electric utility companies have not been able to identify and cure noise

sources over a period of years. ARRL annually devotes hundreds of hours of staff time helping amateurs and power companies try to deal with these problems. In spite of this effort, many of these cases remain unresolved. The improvement in noise levels proposed by Ambient is not practical, based on the documented experience with the utility industry and the condition of power lines, which is, overall, rather poor.

24. The comments of Amperion, Inc. argue that keeping its BPL signals off of residential building electrical wiring (using Wi-Fi or other techniques), the interference potential to radio communications in that home are substantially reduced. While this may be true, it does not address the root problem: the emissions from overhead medium-voltage distribution lines would contribute much more to the overall local interference potential of an installed BPL system. Distribution line phases, no matter how fed, are much better antennas than the closely spaced electrical wiring within a building. Generally, antennas used by amateur operators are not much closer to neighboring homes than they are to distribution wiring. The technique used by Ambient is not a remedy for interference. Furthermore, Amperion notes that it uses spectrum from 1.7-30 MHz. As is the case with all of the BPL manufacturers that filed comments, they do not indicate what frequencies they are actually using in this range.

25. As with other BPL manufacturers, Amperion's only response to the interference potential is to state that they have not had any reports of interference from their field trials. Only one manufacturer conducting such trials has provided ARRL with information about the specific locations of those trials, so ARRL cannot determine whether any amateurs were included in the trial areas. The lack of reports is not a scientific determination of the interference potential of BPL operating at the present FCC

limits, as discussed above. By contrast, ARRL *has* provided significant scientific evidence, with simple path-loss calculations, EZNEC modeling, propagation studies and empirical observation of amateur stations brought into the test areas. This work has yielded a consistent conclusion – that the received signal levels predicted by well-established laws of antenna physics, and assuming the radiated emissions limits in Section 15.209 of the Commission's Rules, result in strong received interfering signals and significant degradation of nearby HF communications channel capability.

26. Amperion also indicates that BPL systems should be considered to be operating in a Class A environment. They indicate, however, that BPL systems closer than 10 meters to a residence should be considered Class B, while systems 30 meters or farther should be considered Class B. This is flawed for several reasons. First, there is a range between 10 and 30 meters that is simply not addressed by their recommendation. While a few amateur fixed-station antennas are indeed located inside residences, most are located outside those residences, often considerably closer to the distribution lines than is the residence. The Commission cannot make an arbitrary distinction that treats some BPL systems as operating in a Class A environment, despite the location of the MV lines in a residential community. Furthermore, increasingly, Amateur Radio HF stations are mobile (as are those of public safety low-band VHF equipment, including State Police, for example) and mobile stations operate on roadways along which power lines are located. Power lines are ubiquitous, and attempts by the BPL industry to obtain relaxed emission classifications based on operating environment are obviously illogical and frivolous.

27. Amperion states that the electric utility industry could use the BPL system for its control applications. The utility industry has already rejected this out of hand,

however, in that it has argued that 1-watt EIRP Amateur signals in the Low Frequency range, where power lines are inefficient antennas, would cause substantial interference to PLC control facilities. They could not apparently withstand 1500 watt transmitter power output levels in the HF bands where power lines are highly susceptible to interference from Amateur signal ingress which could put that system at risk. Therefore, this is simply not a realistic application.

28. Main.net describes its involvement in a number of worldwide trials. Contrary to their claims that there were no reports of harmful interference, many of these overseas trials were accompanied by strong protests from amateur radio operators in those areas. One case of massive interference is well documented in one of the videos made by Austrian amateurs on ARRL's web page. (Refer to http://www.arrl.org/tis/info/HTML/plc/#video.)

29. Main.net also argues that it is not likely that BPL will interfere with cable service "because cable wiring is shielded and insulated." This may be one of the most significant statements made by the BPL industry, because it is clear that most electrical wiring is *not* shielded. It is fundamental that unshielded, wide-spaced conductors should not be used to carry RF signals. As to Amateur interference, Main.net states:

> Although there is some theoretical concern regarding interference to Amateur Radio operations below 30 MHz, Main.net's experience, including operation in the homes of active Amateur Radio licensees, has been that there is no interference. Part of the reason for this is that amateurs typically install their antennas outside.

In the first place, there has been significant interference reported by amateurs overseas. ARRL's own measurements in a trial area using Main.net equipment in Emmaus, PA showed strong received signal levels near the lines, in excess of –100 dBW in a 3 kHz

bandwidth. Main.net's vague statement does not include any reports from these alleged licensees, no information about antenna placement; no data concerning received signal levels, or even an indication that the amateurs involved operated on HF bands. Unfounded assurances that BPL will not cause interference are no substitute for real-world measurements and the FCC should rely on documented test results and an impact of interference potential based on scientific, not marketing, criteria.

30. Main.net indicates that they used an unnamed "third-party test laboratory" to measure the radiated emissions from their systems. Main.net's filing refers the Commission to test reports "02F247" and "02F4092S." If the Commission will be using information in these reports to make decisions in this proceeding, those reports should be made part of the record and ample time should be given to all parties to review and comment on those reports. Main.net suggests that a conducted emissions limit should apply to access BPL systems and proposes a reasonable Line Impedance Stabilization Network (LISN) to make such measurements. They then ask that a conducted emissions limit of –40 dBm/Hz (-70 dBW/Hz) be applied. They then draw an inapplicable analogy:

> As explained by Prof. Hirsch (attached as Appendix A), -40 dBm/Hz is the typical level of background noise produced by Ethernet cabling, which is widely deployed in the home and office indoor environment and has not produced any known interference problems.

This example does not apply well to access BPL. In the first place, very few homes have installed Ethernet systems. Far from being "widely deployed," most Ethernet systems are installed in offices and factories, most of which are located quite a distance from residential environments. Ethernet wiring is usually coaxial cable or high-quality twisted pair wiring, both of which offer significantly less radiating potential than electrical

wiring, which is not well shielded, not designed to carry RF signals, is connected to all types of unknown loads, and has an unknown potential to radiate the signal and end-fed wires caused by every open electrical switch in the circuit. By suggesting that a power level that works for well-controlled Ethernet environment applies to access BPL systems shows a serious ignorance of the EMC principles that were used to determine that a power level of –40 dBm/Hz works for Ethernet systems.

31. Main.net also makes another statement of extreme importance to this proceeding:

> The FCC should also impose out-of-band emissions limits on power-line carrier systems that operate below 1.7 MHz to prevent these systems from causing interference to BPL systems in the future. The same out-of-band emissions limits that apply to other unlicensed devices would be appropriate. (emphasis added.)

Those "out of band emissions limits that apply to other unlicensed devices" are the conducted emissions limits that apply to all devices. Main.net cannot be heard to argue in one part of its comments that such limits are necessary to protect *their* systems from interference, but allege to the Commission that their signals, conducted onto the same mains and wiring, will be much higher without causing harm to other users. The argument is preposterous. For devices other than Class A or incidental emitters, Part 15 rules limit conducted emissions on HF to a level of 250 microvolts, quasi-peak, measured in a 9 kHz bandwidth. Conservatively presumed to be across a 50-ohm load, this is a power level of –59 dBm (-89 dBW). ARRL agrees with Main.net that this conducted emissions limit is necessary to prevent widespread interference to nearby receivers and other devices connected to the AC mains. Main.net alleges that it is necessary to protect its systems with the limits in the present rules. However, Main.net is proposing a

conducted emissions limit of –40 dBm/Hz. In a 9 kHz bandwidth, this is a level of –0.5 dBm, a level that is a whopping 58.5 dB higher than other devices regulated by Part 15. The idea that this will not upset the delicate EMC balance that has evolved for decades is ill conceived and technically naive. All systems, from nearby receiver systems to all devices that derive power from the AC mains deserve the same level of protection that Main.net is requesting for its systems.

32. PowerWan states that BPL standards work has not been done internationally other than through ETSI. PowerWan believes that it is still too early for standards work to be successfully embarked upon, as there are no deployments large enough to provide the real-world experience to prove or disprove technologies and techniques. ARRL agrees with this assessment, and with the fact that the present limited deployments are too small to prove or disprove anything exculpatory with respect to interference potential. Yet the industry has been using these deployments for marketing leverage and, when it suits their purpose, has collectively been quite willing to use them to assert (without support) that there is no interference potential from BPL.

33. Notwithstanding its admission that the interference potential of BPL is unknown, Powerwan asks for an increase in the permitted emissions limits. ARRL has conclusively shown harm to the RF environment from the present limits, and a significant increase in the overall levels of man-made noise in all spectrum that BPL intends to use. They also ask that only radiated emissions measurements be required and that equipment continue to be verified under Part 15 rules. Powerwan also suggests that BPL could be used by the utility industry for Status, Control and Data Acquisition. The arguments

ARRL offered in response to other comments apply equally to the Powerwan views on these subjects.

IV. Comments of Power Utilities

34. The comments of Utilities offer little in the way of new technical argument. However, Southern LINC asserts the following relative to interference testing of BPL:

> Southern also recommends that emissions testing of access BPL be based on average peak measurements, not quasi-peak measurements. The quasi-peak measuring method was developed in the 1930s to measure interference to broadcast radio reception. Accordingly, although the quasi-peak method has evolved over the years, it is not at all clear whether it is the best method for analyzing the interference potential of something as advanced as access BPL. Southern believes that the Commission should closely investigate this issue and give strong consideration to allowing testing of access BPL to based on average peak measurements (sic).

The use of quasi-peak detection for EMC measurements has withstood the test of time, so it is not at all reasonable to state that its use is "not clear." QP detection has been used successfully for the measurement of conducted and radiated emissions measurements for many types of broadband emitters, such as computer monitors or switch-mode power supplies. At HF, the measurement bandwidth is 9 kHz. This is a reasonable approximation of the range of bandwidth that is typical for HF communications receivers. Amateur SSB communications channels are typically around 2800 Hz bandwidth, for example. At the emissions levels stipulated in Part 15, with typical antenna gain used by stations operating in the Amateur Radio Service, BPL emissions in the passband of that receiver will generate receiver responses well into the automatic gain control (AGC) region of the receiver. From its years of measurements of amateur communications receivers, ARRL notes that virtually all receivers respond to the peak signal present in its passband for AGC control. For that reason, the quasi-peak detection that has evolved

after decades of experience is a good predictor of the interference potential to communications capability. In ARRL's view, those who ask that the use of quasi-peak detectors be changed must provide a more scientific basis for that change than a claim that "it is not at all clear" that quasi-peak detection is appropriate to determine access BPL interference potential.

V. ARRL's Interference Measurements at Test Sites

35. In contrast to the blanket statements of many BPL advocates that there have been no interference reports from test sites, ARRL would note that its own field measurements lead inescapably to the conclusion that BPL will, if deployed, create widespread harmful interference. With reference to Exhibit A attached, ARRL notes that it has done extensive measurements in four of the BPL trial areas. The testing showed severe interference potential from the BPL implementations used in the trial areas. ARRL would urge that the Commission view the video that is available at:
http://www.arrl.org/tis/info/HTML/plc/#Video
in order to understand the extent of the interference problems that Amateurs will inevitably experience if BPL is implemented. The measurements validate the calculations that were submitted with ARRL's comments in this proceeding. The primary purpose of the visits to the field trial areas, however, was to use listening tests to demonstrate and document the applicability of ARRL's interference calculations to the real-world impact of BPL emissions on HF communications circuits.

36. In some cases, the power lines were located near the roads traveled with mobile communications equipment described in the Summary Report, Exhibit A hereto. However, in some cases, the Amateur station was located as much as 50 meters from the

power lines, and strong interference was received at these distances as well. The antennas used were not the high-gain antennas typically deployed at a residential amateur station, and therefore the actual interference in residential areas would be much worse than that noted in the studies conducted by ARRL. ARRL made no compliance measurements, but rather field strength measurements. The conclusion from the field tests is, as ARRL had previously predicted, that at the signal levels presently permitted by the Commission's Part 15 rules, harmful interference will inevitably be caused to nearby HF stations.

VI. Conclusions

37. The comments in this proceeding from Amateur Radio operators reinforce, and the comments from BPL advocates offer nothing to rebut, ARRL's conclusion that the concept of expanded PLC systems at HF and low-band VHF is flawed. There is currently a multitude, and probably sufficient array, of competitive broadband delivery mechanisms. But for the severe interference potential from, especially, access BPL to licensed Amateur Radio operation, it might be reasonable to add BPL as a competitive means of providing internet access through existing infrastructure. As it is, ***BPL cannot be utilized as a broadband delivery system***. The Commission has stated as a fundamental principle that incumbent, licensed radio services, including the Amateur Service, must be protected from interference from any deployment of BPL. However, premised on the calculations previously filed, and the actual field measurements and interference evaluation conducted by ARRL and summarized in Exhibit A hereto, there is no compatibility between BPL and Amateur operation at HF or VHF. Nor is there any means of addressing or rectifying interference events when the inevitable interference is experienced.

38. The Commission has thus far acted only as a cheerleader for BPL. It is past time that the Commission acted in its proper role as a steward of the radio spectrum, and recognized the interference potential of BPL to the sensitive incumbent licensed services in these bands. The Commission cannot stretch the Part 15 regulations as far as would be required to accommodate BPL. As noted in the ARRL's comments, present Part 15 regulations were designed to protect against interference from devices that would radiate or conduct signals on a localized basis. The devices for which the Rules were designed typically emit signals only on specific frequencies or bands. BPL systems will occupy all of the HF, low VHF and some MF bands. The relatively high emission limits that work for individual point-source radiators are inapplicable to BPL systems. BPL system radiated levels are complex and difficult to measure due to the length of the powerline acting as an antenna. The increase in noise levels in residential areas over current ambient levels is reasonably calculated and measured to be devastatingly high, due to the efficiency of the power lines as radiators. And the comments in this proceeding are silent on interference susceptibility of BPL to signal ingress from Amateur stations. Although ARRL cannot as yet provide test data on this ingress, a simple path loss calculation from a 1500 watt Amateur station with a typical three-element Yagi type antenna predicts that as much as 25 watts of signal could be induced into overhead power lines located 30 meters from the antenna, conservatively estimating 0 dBi for the power line gain. Even reducing this by 20 dB estimates that 250 milliwatts of RF power would be introduced into the line, and at this level it is quite likely that the BPL system would be degraded or rendered inoperative due to fundamental (brute force) overload of the BPL modem. This

is a consumer protection problem which stands to ruin the Amateur Service. The Commission cannot allow this to occur.

Therefore, the foregoing considered, ARRL, the National Association for

Amateur Radio, again respectfully requests that the Commission take no steps to permit access or in-building BPL at HF or VHF.

Respectfully submitted,

ARRL, the National Association For Amateur Radio

225 Main Street
Newington, CT 06111-1494

By: Christopher D. Imlay
Christopher D. Imlay
Its General Counsel

Booth, Freret, Imlay & Tepper, P.C.
14356 Cape May Road
Silver Spring, MD 20904-6011
(301) 384-5525

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